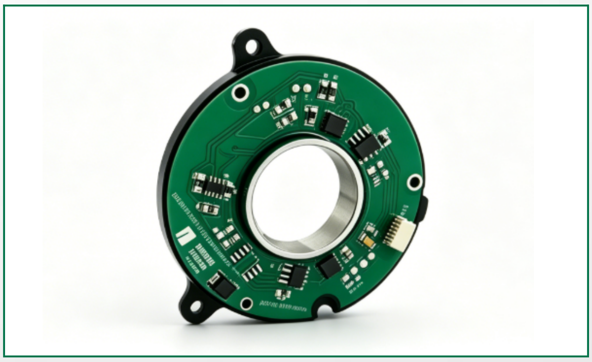
绝对式编码器

User's manual of

Absolute encoder

使用说明书



SAR58K24 · 系列

长春荣德光学有限公司

CHANGCHUN RONGDE OPTICS CO.,LTD

1.1 Appearance Features

Appearance:

1、Surface treatment: black oxidation, three-proof treatment.
2、Cable length: 0.2m(customizable)

Features:

1. Common installation method in the market.
2. No bearings, ultra-thin size, ultra-light weight.
3. Photoelectric reflective absolute encoder, high precision.
4. Can realize multiple communication protocols.
5. Applicable to various industries, such as: robots, turntables, pods and other industries.
6. Support customization

1.2 Model Description

1.2.1 Asynchronous serial communication model definition

SAR 58 K 24 - 16 - 1 - T A B B - T R

- SAR — Classification: RCA:Photoelectric split
- 58 — Outer diameter: Φ58mm
- K — Shaft diameter type: K:Hollow shaft
- 24 — ID: Φ10-24mm
- 16 — Resolution: 10-24bit
- 1 — Operating voltage: 1: DC5V±5%; 2: DC10-30V
- T — Communication interface: R: RS422; T: RS485; E: RS232
- A — Baud rate: A: 115200; B: 57600; E: 38400; F: 19200; G: 9600; H: 4800
- B — Update rate: A: 2000Hz; B: 1000Hz; C: 500Hz; D: 400Hz; E: 200Hz; F: 100Hz; G: 50Hz; H: 20Hz
- B — Code: B: Binary code; G: Gray code
- T — Communication: T: Timed transmission; TC: Timed + clear; C: Pulse handshake; CC: Handshake + clear; B: Bus command; BC: Bus + clear; M: MODBUS
- R — Outlet: R: Side exit of the plug-in

1.2.2 CANopen. SSI. BISS-C

SAR 58 K 24 - 16 - 1 - C B R

- SAR — Classification: RCA:Photoelectric split
- 58 — Outer diameter: Φ58mm
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- 24 — ID: Φ 10-24mm
- 16 — Resolution: 10-24bit
- 1 — Operating voltage: 1: DC5V±5%; 2: DC10-30V
- C — Protocol: S:SSI; C:CANopen; B:BISS-C
- B — Output code: B: Binary code; G: Gray code
- R — Outlet: R: Side exit of the plug-in

1.3 ATTENTION

1. In order to ensure product accuracy and service life, please use the soft connection strictly according to the instructions;
2. This product is a precision instrument, which has been strictly calibrated before leaving the factory. Do not force the encoder to collide;
3. In order to ensure the normal operation and accuracy of the encoder, the working voltage is DC5V±5%:

① The length of the power cord shall not exceed 2 meters.
② The power supply current shall not be less than 0.5A.
③ The power supply voltage is within ±50mV.

1. In order to ensure product accuracy and service life, please use the soft connection strictly according to the instructions;
2. This product is a precision instrument, which has been strictly calibrated before leaving the factory. Do not force the encoder to collide;

3. In order to ensure the normal operation and accuracy of the encoder, when the working voltage is DC5V±5%: When the working voltage is 10-30V:

① The power supply current shall not be less than 0.3A.
② The power supply voltage is within ±50mV.

4. The product shall be installed and used by professionals. Pay attention to the power supply voltage and line sequence corresponding to the equipment connection to ensure the normal operation of the encoder.
5. Fixation: The encoder is firmly installed to prevent errors caused by vibration or displacement.
6. Cleaning: Keep the reflective surface clean to avoid dust or stains affecting the reflection effect.

2. 1 Basic parameters

Resolution	10-24bit	Measuring range	0～360° (single t u r n measurement range)

Resolution	13 bit	14 bit	15 bit	16 bit	17 bit	18bit	19bit	20bit	21bit	22bit	23bit	24bit
Resolution ratio	160″	80″	40″	20″	10″	5″	2.5″	1.25″	0.6″	0.3″	0.15″	0.08″
Accuracy ≤	±320″	±160″	±80″	±40″	±40″	±40″	±40″	±40″	±40″	±40″	±40″	±40″

2. 2 Environmental parameters

Working temperature	-40℃~+65℃	IP	N/A
Storage temperature	-50℃~+70℃		

2. 3 Mechanical parameters

Outer diameter	58 mm	Diameter of shaft	10-24 mm
Height	9 mm	Shaft length	8mm
Weight	40 g	Maximum speed	3000 r/min
Resistant to vibration	2.5 g	Radial / axial load	≤20N
Shock resistance	20 g	Axial shaft load	≤10N

2. 4 Electrical parameters

（一）Asynchronous serial

Voltage	DC5V，10～30V
Interface	RS485、RS422、RS232、CAN
Communicating protocol	MODBUS, CANopen, timed send, timed + clear, pulse handshake, handshake + clear, bus command, bus + clear
Baud rate	115200、57600、38400、19200、9600、4800、2400
Refresh rate	2000Hz、1000Hz、500 Hz、400 Hz、200 Hz、100 Hz、50 Hz、20 Hz
Output code	Binary code, Gray code

（二）Synchronous serial communication

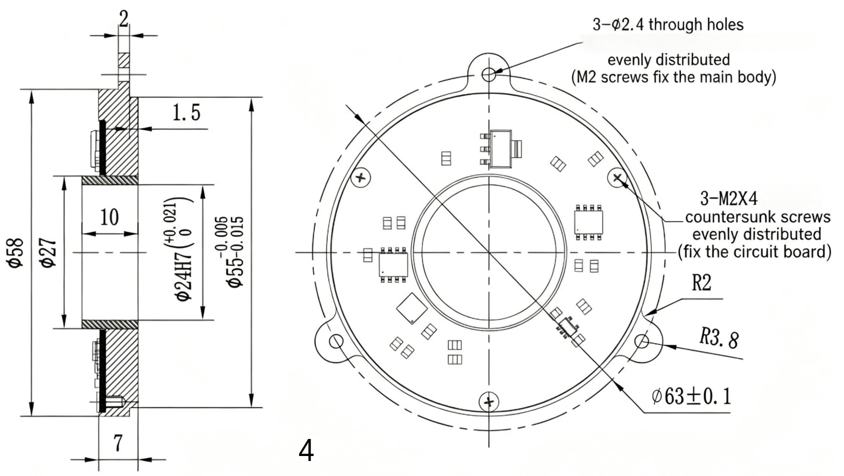
Voltage	DC5V，10～30V
Communicating protocol	SSI、BISS-C
Output code	Binary code, Gray code

2. 5 Mechanical dimensions

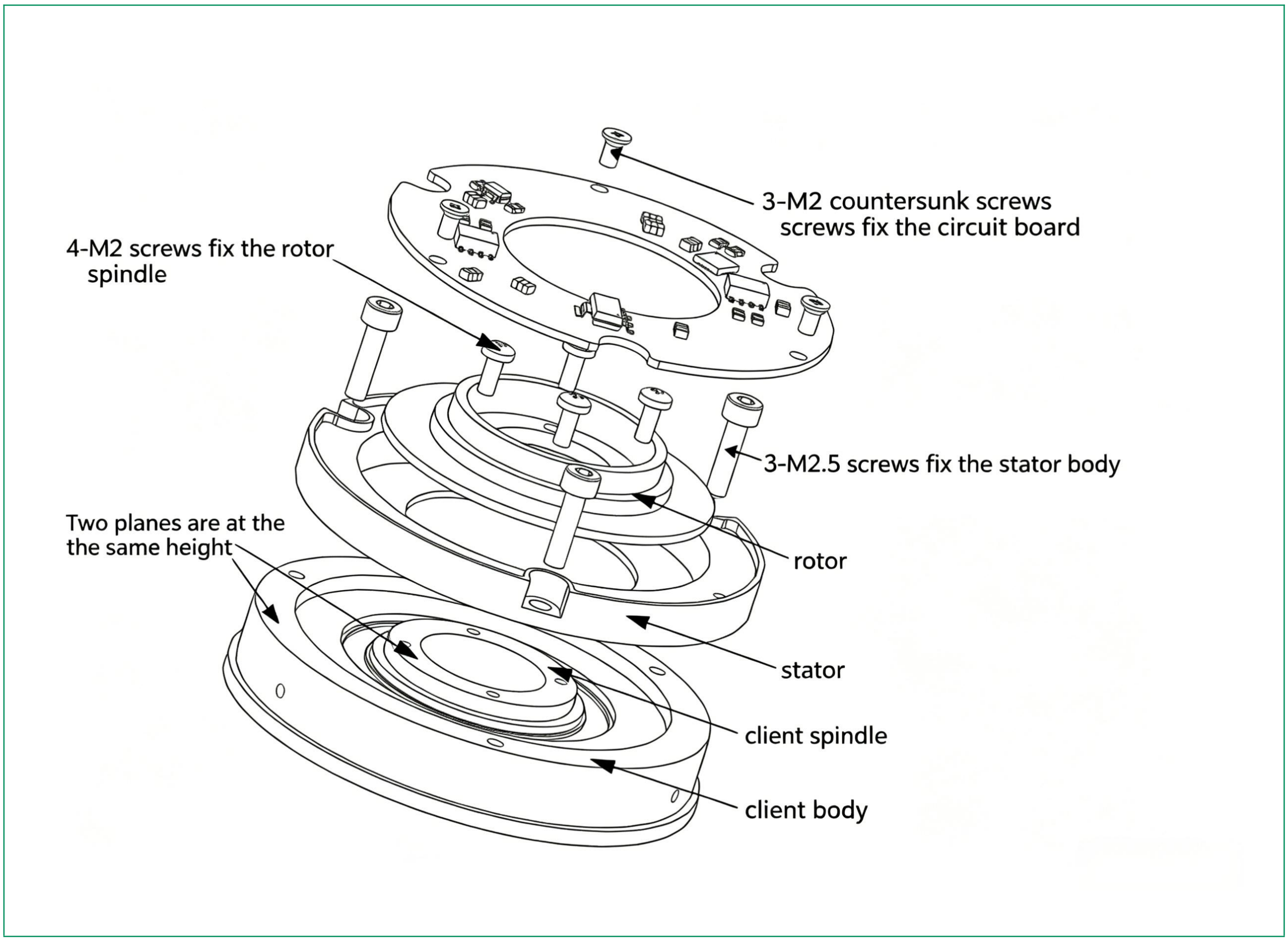
Dimensions in mm

Tolerance GB 1801-2009

ISO1829-1975



2. 6 Installation diagram



Product communication

Asynchronous serial: one byte is 10 bits, 1 bit start bit 0, 1 bit stop bit 1, 8 bits data bits, no parity check bit, 8 bits data bits are transmitted first low and then high; (parity check or even check can be added according to customer requirements)

3. 1 RS485

chip--MAX485 ESA (250kbps) or MAX13443EESA (10Mbps)

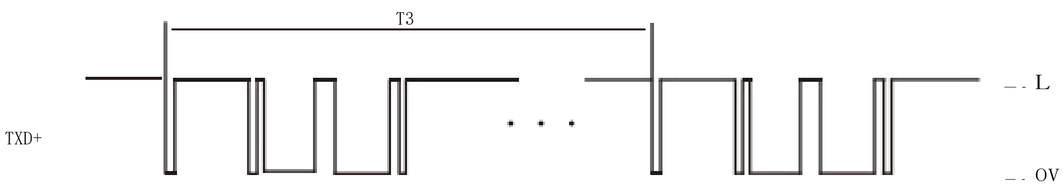
3.1.1 Timed sending

(1) Output the data waveform

For example, 0xff 0x81 0xd0...

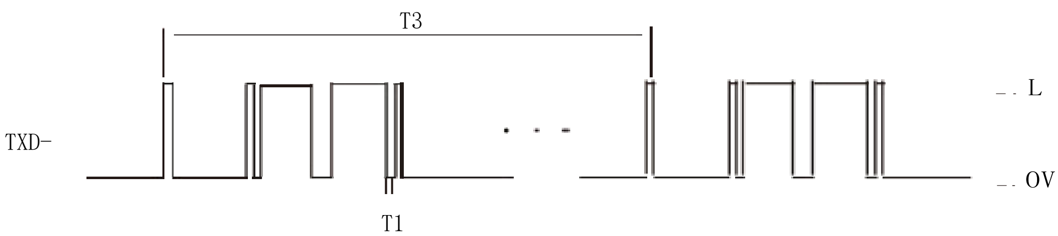
■TXD+ bit transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1...

3.3V≤L≤5V



■TXD-bit transmission: 1 0000 0000 0 1 0111 1110 0 1 1111 0100 0...

3.3V≤L≤5V



T1: Port rate. T3: Update rate

(2) data frame format

	First byte	The second byte	The third byte	The fourth byte	Fifth byte	The sixth byte	The seventh byte
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight in the middle	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	Next high	Eight of them are Chinese	Low octaves	check sum

(The checksum is the sum of the first n bytes of data with the lower 8 bits. 16 bits or less n=4, 17-24 bits n=5, and more than 24 bits n=6)

(3) mode of connection

pigment	red	black	yellow	hispid arthraxon	white	shield
Signal definition	VCC	0V	TXD+	TXD-	NC	G

(4) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H are present. The calculation results are: a = 383, n = 14, θ = (360° × 383)/214, θ = (360° × 383)/16384, and θ = 8.4155°.

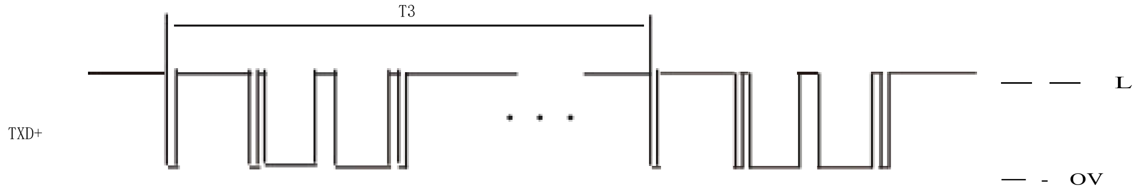
3.1.2, timing + clearing

(1) Output the data waveform

For example, 0xff 0x81 0xd0...

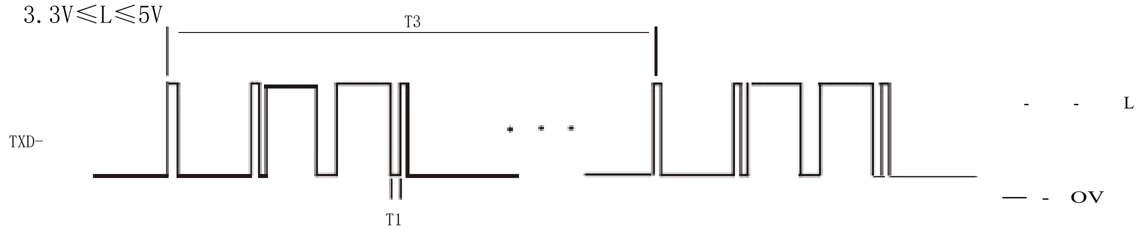
■TXD+ bit transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1...

3.3V≤L≤5V



■TXD-bit transmission: 1 0000 0000 0 1 0111 1110 0 1 1111 0100 0...

3. 3V≤L≤5V



T1: Port rate T3: update rate

(2) data frame format

	First byte	The second byte	The third byte	The fourth byte	Fifth byte	The sixth byte	The seventh byte
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight of them are Chinese	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	Next high	Eight of them are Chinese	Low octaves	check sum

(The checksum is the sum of the first n bytes of data with the lower 8 bits. 16 bits or less n=4, 17-24 bits n=5, and more than 24 bits n=6)

(3) mode of connection

pigment	red	black	yellow	hispid arthraxon	white	shield
Signal definition	VCC	0V	TXD+	TXD-	CLR	G

(4) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H are present. The calculation results are: a = 383, n = 14, θ = (360° × 383)/214, θ = (360° × 383)/16384, and θ = 8.4155°.

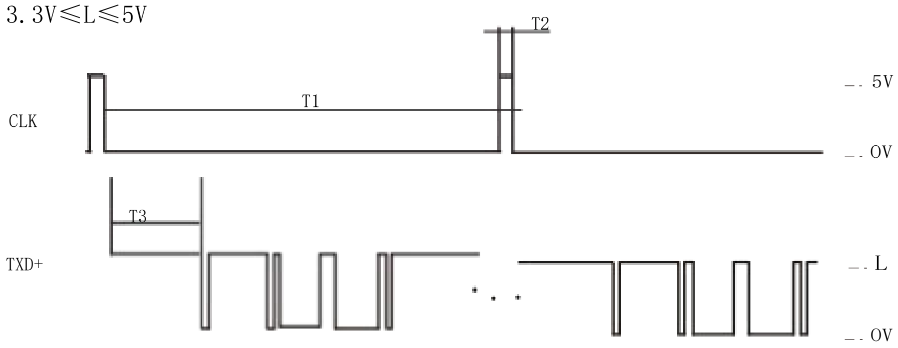
3.1.3 Pulse handshake

(1) Output the data waveform

For example, 0xff 0x81 0xd0...

TXD+ bit transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1...

3. 3V≤L≤5V



The falling edge of the external pulse signal triggers the encoder to work T2≥ 10us

T3: The signal acquisition and processing time after receiving the falling edge of the external pulse

T1-T3: Data transmission time

T1 and T3 vary according to the actual requirements or needs of customers.

(2) data frame format

	First byte	The second byte	The third byte	The fourth byte	Fifth byte	The sixth byte	The seventh byte
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight of them are Chinese	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	Next high	Eight of them are Chinese	Low octaves	check sum

(The checksum is the sum of the first n bytes of data with the lower 8 bits. 16 bits or less n=4, 17-24 bits n=5, and more than 24 bits n=6)

(3) mode of connection

pigment	red	black	yellow	hispid arthraxon	white	shield
Signal definition	VCC	0V	TXD+	TXD-	CLK	G

(4) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H. The calculation results are: a=383, n=14, θ=(360°×383)/214, θ=(360°×383)/16384, and θ=8.4155°.

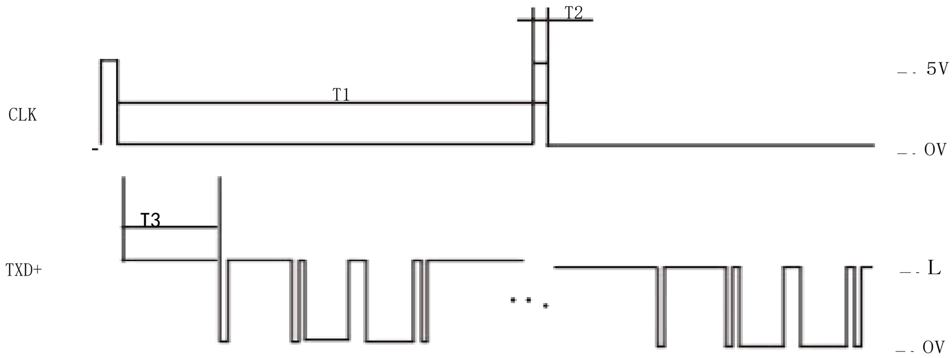
3.1. 4 Shake hands + reset

(1) Output the data waveform

For example, 0xff 0x81 0xd0...

TXD+ bit transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1...

3. 3V≤L≤5V



The CLR pin is usually at 3.3V and the signal falls on the pulse VL<0.5V product reset.

3. 1. 5 Bus commands

(1) control command：

BC AA BX (BX: is the command number. If the customer has no special requirements, each product in the same batch has a unique command number,
And use it as the product address number)
For example, for three products in the same batch, the control commands BC AA B1, BC AA B2 and BC AA B3 correspond to the return data FF B1......, FF B2......, FF B3......, and the second byte of the return data is the product address number.

(2) data frame format

	First byte	The second byte	The third byte	The fourth byte	Fifth byte	The sixth byte	The seventh byte
control command	BCH	AAH	BXH				
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight of them are Chinese	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	Next high	Eight of them are Chinese	Low octaves	check sum

(The checksum is the sum of the first n bytes of data with the lower 8 bits. If n = 4, the sum is 16 bits or less; if n = 5, the sum is 24 bits or less; if n = 6, the sum is 24 bits or more.)

(3) mode of connection

pigment	red	black	yellow	hispid arthraxon	white	shield
Signal definition	VCC	0V	TXD+	TXD-	NC	G

(4) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H. a=383, n=14,

θ= (360° ×383) /214 , θ= (360° ×383) /16384, θ=8.4155°。

3.1.6 Bus + Reset

(1) control command：

BC AA BX (BX: is the command number. If the customer has no special requirements, each product in the same batch has a unique command number,
And use it as the product address number)
For example, for three products in the same batch, the control commands BC AA B1, BC AA B2 and BC AA B3 correspond to the return data FF B1......, FF B2......, FF B3......, and the second byte of the return data is the product address number.

Zeroing order:

BC AA CX (CX: is the zeroing command. If the customer has no special requirements, each product in the same batch has a unique zeroing command, usually
The X number in the zeroing command corresponds to the X number in the control command)
For example, the zeroing command for a product with control command BC AA B1 is BC AA C1.

(2) data frame format

	First byte	The second byte	The third byte	The fourth byte	Fifth byte	The sixth byte	The seventh byte
control command	BCH	AAH	BXH				
Zeroing order	BCH	AAH	CXH				
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight of them are Chinese	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	Next high	Eight of them are Chinese	Low octaves	check sum

(The checksum is the sum of the first n bytes of data with the lower 8 bits. If n is 4, the sum is 16 bits or less; if n is 5, the sum is 24 bits or less; if n is 6, the sum is 24 bits or more.)

(3) mode of connection

pigment	red	black	yellow	hispid arthraxon	white	shield
Signal definition	VCC	0V	TXD+	TXD-	NC	G

(4) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H. The calculation results are: a=383, n=14, θ=(360°×383)/214, θ=(360°×383)/16384, and θ=8.4155°.

3.1. 7 MODBUS protocol

(1) Modbus communication protocol (RTU mode).

(2) Port rate is optional: 2400bps, 4800bps, 9600bps, 19200bps, 57600bps

(3) Factory default Settings: ① No parity bit ② Port rate 19200bps ③ Address 0x01④ Start address 0x00 0x00

Note: When changing parameters, do not send them regularly to avoid damaging the internal structure of the device. Send a return data match to indicate that the setting is successful.

(4) Function code 03:

Use the 03 function code of Modbus communication protocol to read the encoder value.
The command format of the host is the slave address, function code, starting address, number of bytes and CRC code.
The data format of the slave response is the slave address, function code, data area and CRC code. The data in the data area is binary code, two bytes (or three bytes), with the high bits first. The CRC code is two bytes, with the low bits first.

(5) data frame format：

① Read the real-time data of the encoder below 16 bits. Host call: The address of the slave is 01.

01	03	00	00	00	01	84	0A
Station number address	FC	start address		Read the point count		CRC check code (low bit first)	

Encoder answers:

01	03	02	XX	XX	XX	XX
Station number address	FC	Independent byte	Data (high values first)		CRC check code (low bit first)	

② Read real-time data-more than 16 bits and less than 32 bits. Host call: Slave address is 01.

01	03	00	00	00	02	C4	0B
Station number address	FC	start address		Read the point count		CRC check code (low bit first)	

Encoder answers:

01	03	04	XX	XX	XX	XX	XX	XX
Station number address	FC	Independent byte	Data (high values first)				CRC check code (low bit first)	

The fields 01,03,02, and XX each occupy one byte. The data consists of two bytes, with the high byte positioned first. Each frame contains at least 3.5 bytes of time interval between its start and end. When programming the host, users should retain the above content unchanged for all other byte characters except the station number (address) and CRC checksum. The host format may specify either 01 or 02 as read points (02 being compatible with certain protocols). The function code (03) in the slave's response frame remains unchanged.

③ Query the device address

The host is down	FF	A0	40	38
The encoder replied	FF	A0	01 (Station number and address)	XX XX (CRC check code, the lower bit is in front)

④ Change the device address

The steps to calculate CRC code are:

① The preset 16-bit register is hexadecimal FFFF (that is, all 1s). This register is called CRC register;

② The first 8 bits of the data are OR with the lower bits of the 16-bit CRC register, and the result is placed in the CRC register;

③ Shift the contents of the register right by one bit (towards the low bit), fill in the highest bit with 0, and check the lowest bit;

④ If the lowest bit (the one that is shifted out) is 0: repeat step 3 (shift again)

If the least significant bit (the one that is shifted out) is 1: the CRC register is XORed with polynomial A001 (1010 0000 0000 0001);

⑤ Repeat steps 3 and 4 until the right shift is 8 times, so that all the 8-bit data has been processed;

⑥ Repeat steps 2 to 5 to process the next 8-bit data;

⑦ Finally, the obtained CRC register is the CRC code.

⑧ When the CRC result is put into the information frame, the high and low bits are exchanged, with the low bits in front.

(6) mode of connection

pigment	red	black	yellow	hispid arthraxon	white	shield
Signal definition	VCC	0V	TXD+	TXD-	NC	G

(7) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H. The data bits 01H 7FH (decimal number 383) and the checksum 00H are calculated as follows: a=383, n=14, θ=(360°×383)/214, θ=(360°×383)/16384, and θ=8.4155°.

3. 2 RS232 —— RS232interface chip---- MAX232

ESA

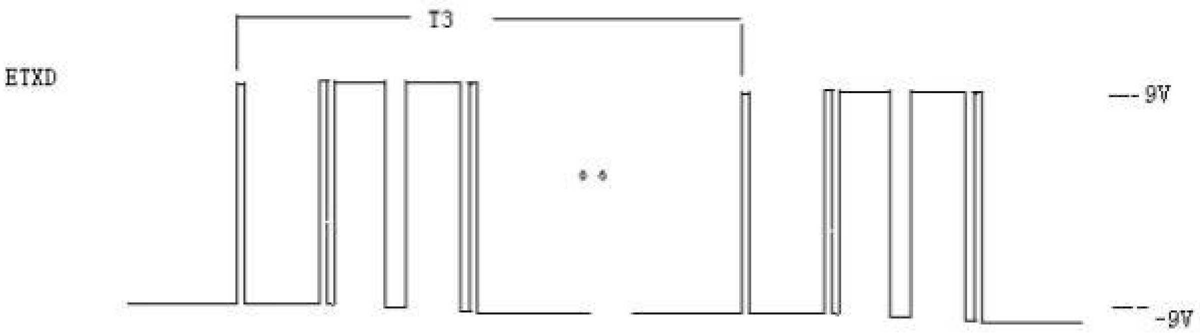
3. 2. 1定时发送

(1) Timed sending

(1) Output the data waveform

For example, 0xff 0x81 0xd0...

TXD+ bit transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1...



T3：更新率

(2) data frame format

	First byte	The second byte	The third byte	The fourth byte	Fifth byte	The sixth byte	The seventh byte
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight of them are Chinese	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	Next high	Eight of them are Chinese	Low octaves	check sum

(The checksum is the sum of the first n bytes of data with the lower 8 bits. 16 bits or less n=4, 17-24 bits n=5, and more than 24 bits n=6)

(3) mode of connection

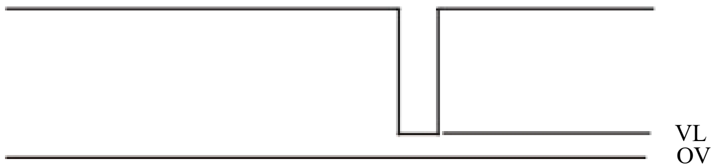
pigment	red	black	yellow	hispid arthraxon	white	shield
Signal definition	VCC	0V	ETXD	NC	CLR	G

(4) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H are present. The calculation results are: a=383, n=14, θ=(360°×383)/214, θ=(360°×383)/16384, and θ=8.4155°.

(5) Zeroing signal:

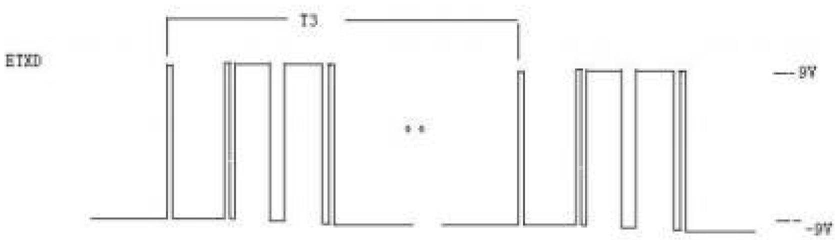


The CLR pin is usually at 3.3V and the signal falls on the pulse VL<0.5V product reset.

3.2.2 timing + clearing

(1) Output the data waveform

For example, 0xff 0x81 0xd0...
TXD+ bit transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1...



T3: Update rate

(2) data frame format

	First byte	The second byte	The third byte	The fourth byte	Fifth byte	The sixth byte	The seventh byte
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight of them are Chinese	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	Next high	Eight of them are Chinese	Low octaves	check sum

(The checksum is the sum of the first n bytes of data, taking the lower 8 bits. 16 bits or less n=4, 17-24 bits n=5, and more than 24 bits n=6)

(3) mode of connection

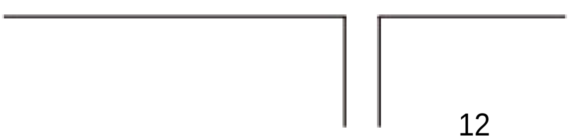
pigment	red	black	yellow	hispid arthraxon	white	shield
Signal definition	VCC	0V	ETXD	NC	CLR	G

(4) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H are present. The calculation results are: a = 383, n = 14, θ = (360° × 383)/214, θ = (360° × 383)/16384, and θ = 8.4155°.

(5) 清零信号:



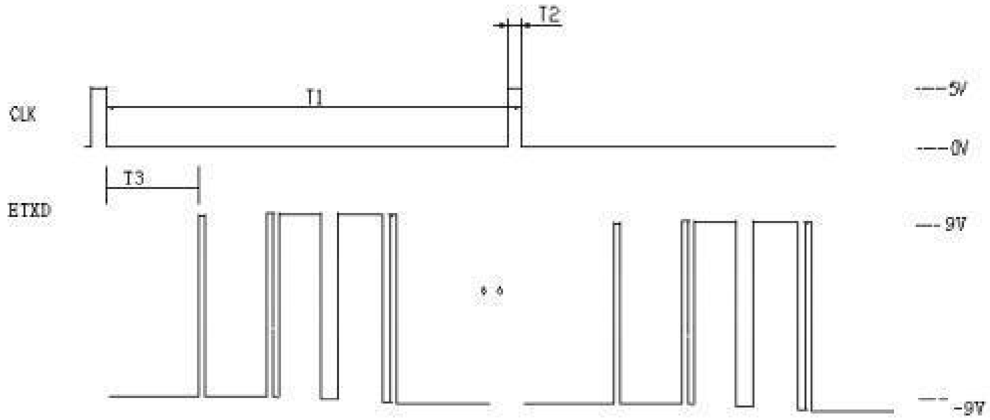
The CLR pin is usually at 3.3V and the signal falls on the pulse VL<0.5V product reset.

3.2.3 Pulse handshake

(1) Output the data waveform

For example, 0xff 0x81 0xd0...

TXD+ bit transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1...



Pulse handshake: The encoder is triggered by the falling edge of an external pulse signal

T2>=10us

T3: The signal acquisition and processing time after receiving the falling edge of the external pulse

T1-T3: Data transmission time

T1 and T3 vary according to the actual requirements or needs of customers.

(2) data frame format

	First byte	The second byte	The third byte	The fourth byte	Fifth byte	The sixth byte	The seventh byte
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight of them are Chinese	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	Next high	Eight of them are Chinese	Low octaves	check sum

(The checksum is the sum of the first n bytes of data with the lower 8 bits. 16 bits or less n=4, 17-24 bits n=5, and more than 24 bits n=6)

(3) mode of connection

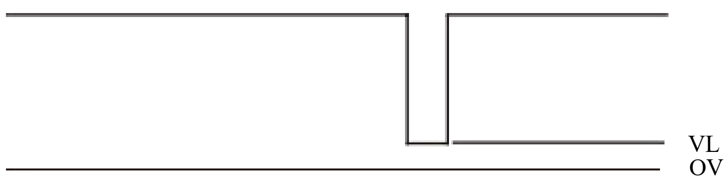
pigment	red	black	yellow	hispid arthraxon	white	shield
Signal definition	VCC	0V	ETXD	NC	CLK	G

(4) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H. The calculation results are: a=383, n=14, θ= (360° × 383)/214, θ= (360° × 383)/16384, and θ=8.4155°.

(5) 清零信号：



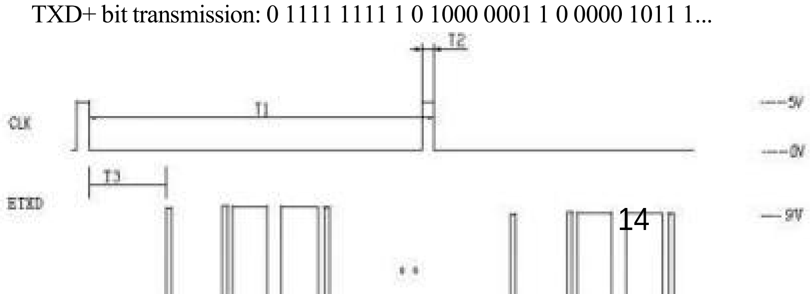
The CLR pin is usually at 3.3V and the signal falls on the pulse VL<0.5V product reset.

3. 2. 4 handshake + clear

(1) Output the data waveform

For example, 0xff 0x81 0xd0...

TXD+ bit transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1...



Pulse handshake: The encoder is triggered by the falling edge of the external pulse signal. T2>=10us

T3: The signal acquisition and processing time after receiving the falling edge of the external pulse

T1-T3: Data transmission time

T1 and T3 vary according to the actual requirements or needs of customers.

(2) data frame format

	First byte	The second byte	The third byte	The fourth byte	Fifth byte	The sixth byte	The seventh byte
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight of them are Chinese	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	Next high	Eight of them are Chinese	Low octaves	check sum

(The checksum is the sum of the first n bytes of data with the lower 8 bits. 16 bits or less n=4, 17-24 bits n=5, and more than 24 bits n=6)

(3) mode of connection

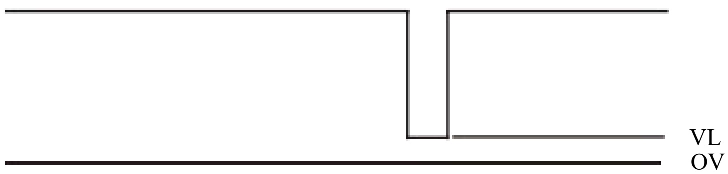
pigment	red	black	yellow	hispid arthraxon	ash	white	Citrus sinensis	palm	shield
Signal definition	VCC	0V	ETXD	NC	CLK	CLR	NC	NC	G

(4) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H are present. The calculation results are: a = 383, n = 14, θ = (360° × 383)/214, θ = (360° × 383)/16384, and θ = 8.4155°.

(5) 清零信号:



The CLR pin is usually at 3.3V and the signal falls on the pulse VL<0.5V product reset.

3. 2. 5 Bus commands

(1) control command：

BC AA BX (BX: is the command number. If the customer has no special requirements, each product in the same batch has a unique command number and uses it as the product address number)

For example, for three products in the same batch, the control commands BC AA B1, BC AA B2 and BC AA B3 correspond to the return data FF B1......, FF B2......, FF B3......, and the second byte of the return data is the product address number.

(2) data frame format

	First byte	The second byte	The third byte	The fourth byte	Fifth byte	The sixth byte	The seventh byte
control command	AAH	81H	CCH	DDH			
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight in the middle	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	Next high	Eight of them are Chinese	Low octaves	check sum

(The checksum is the sum of the first n bytes of data with the lower 8 bits. If n = 4, the sum is 16 bits or less; if n = 5, the sum is 24 bits or less; if n = 6, the sum is 24 bits or more.)

(3) mode of connection

pigment	red	black	yellow	hispid arthraxon	white	shield
Signal definition	VCC	0V	ETXD	NC	CLK	G

(4) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H are present. The calculation results are: a = 383, n = 14, θ = (360° × 383)/214, θ = (360° × 383)/16384, and θ = 8.4155°.

3. 2. 6 Bus + reset

(1) control command：

BC AA BX (BX: is the command number. If the customer has no special requirements, each product in the same batch has a unique command number,

And use it as the product address number)

For example, for three products in the same batch, the control commands BC AA B1, BC AA B2 and BC AA B3 correspond to the return data FF B1......, FF B2......, FF B3......, and the second byte of the return data is the product address number.

Zeroing order:

BC AA CX (CX: is the zeroing command. If the customer has no special requirements, each product in the same batch has a unique zeroing command,

Usually the X number in the zeroing command corresponds to the X number in the control command)

For example, the zeroing command for a product with control command BC AA B1 is BC AA C1.

(2) data frame format

	First byte	The second byte	The third byte	The fourth byte	Fifth byte	The sixth byte	The seventh byte
control command	AA H	81 H	CC H	DDH			
Zeroing order	BCH	AAH	CXH				
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight of them are Chinese	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	Next high	Eight of them are Chinese	Low octaves	check sum

(The checksum is the sum of the first n bytes of data with the lower 8 bits. If n = 4, the sum is 16 bits or less; if n = 5, the sum is 24 bits or less; if n = 6, the sum is 24 bits or more.)

(3) mode of connection

pigment	red	black	yellow	hispid arthraxon	white	shield
Signal definition	VCC	0V	ETXD	RTXD	NC	G

(4) Angle conversion formula

$\theta=(360° \times a)/2^n$. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H are present. The calculation results are: a = 383, n = 14, θ = (360° × 383)/214, θ = (360° × 383)/16384, and θ = 8.4155°.

3. 3 RS422

RS422interface chip---- ESA

MAX3087

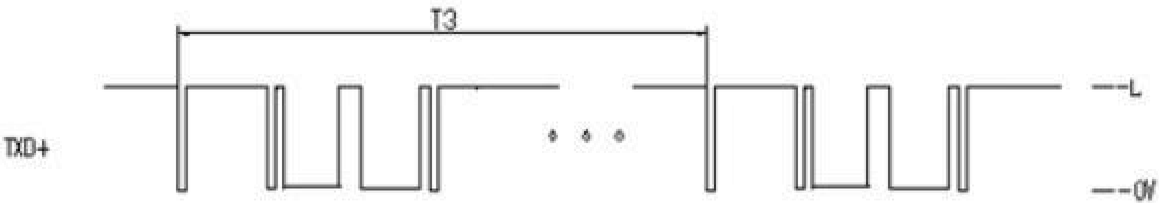
3. 3. 1 Timed sending

(1) Output the data waveform

For example, 0xff 0x81 0xd0...

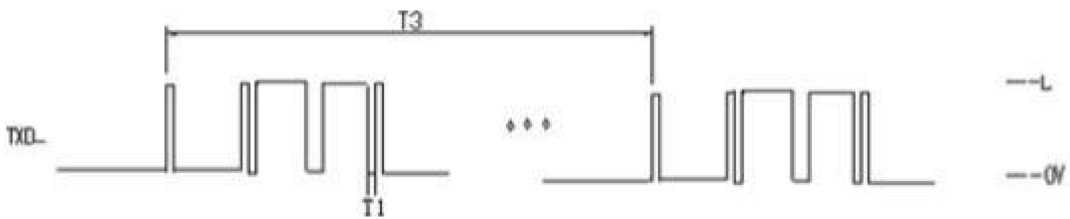
■TXD+ bit transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1...

3.3V≤L≤5V



■ XD-bit transmission: 1 0000 0000 0 1 0111 1110 0 1 1111 0100 0...

3. 3V≤L≤5V



T1: Port rate T3: update rate

(2) data frame format

	First byte	The second byte	The third byte	The fourth byte	Fifth byte	The sixth byte	The seventh byte
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight of them are Chinese	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	Next high	Eight of them are Chinese	Low octaves	check sum

(The checksum is the sum of the first n bytes of data with the lower 8 bits. 16 bits or less n=4, 17-24 bits n=5, and more than 24 bits n=6)

(3) mode of connection

pigment	red	black	yellow	hispid arthraxon	white	shield
Signal definition	VCC	0V	TXD+	TXD-	NC	G

(4) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H are present. The calculation results are: a = 383, n = 14, θ = (360° × 383)/214, θ = (360° × 383)/16384, and θ = 8.4155°.

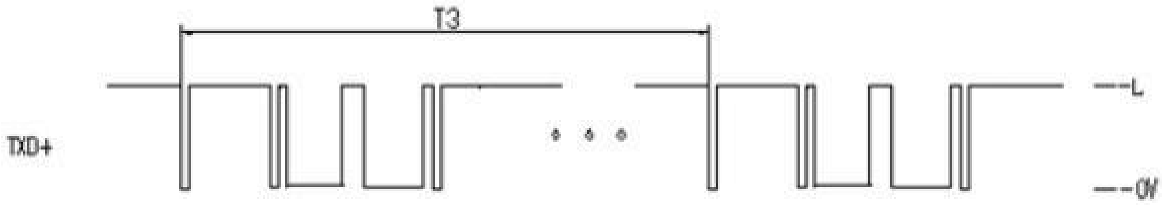
3. 3. 2 timing + clearing

(1) Output the data waveform

For example, 0xff 0x81 0xd0...

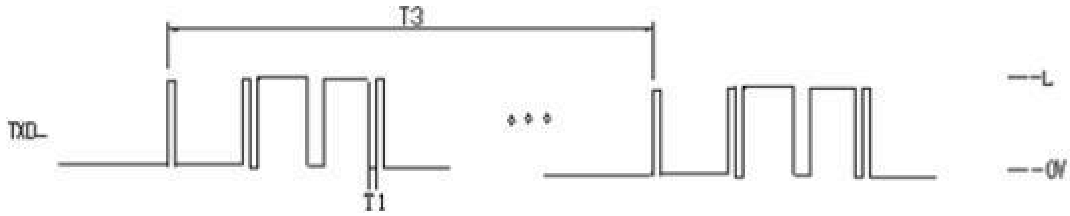
■TXD+ bit transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1...

3. 3V≤L≤5V



■ TXD-bit transmission: 1 0000 0000 0 1 0111 1110 0 1 1111 0100 0...

3. 3V≤L≤5V



T1: Port rate T3: update

(2) Data frame format

	First byte	The second byte	The third byte	The fourth byte	Fifth byte	The sixth byte	The seventh byte
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight of them are Chinese	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	Next high	Eight of them are Chinese	Low octaves	check sum

(The checksum is the sum of the first n bytes of data with the lower 8 bits. 16 bits or less n=4, 17-24 bits n=5, and more than 24 bits n=6)

(3) mode of connection

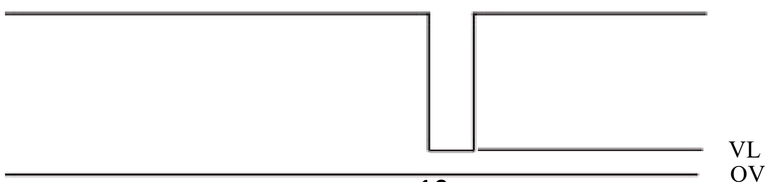
pigment	red	black	yellow	hispid arthraxon	white	shield
Signal definition	VCC	0V	TXD+	TXD-	NC	G

(4) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H are present. The calculation results are: a = 383, n = 14, θ = (360° × 383) / 214, θ = (360° × 383) / 16384, and θ = 8.4155°.

(5) 清零信号：



The CLR pin is usually at 3.3V and the signal falls on the pulse VL<0.5V product reset.

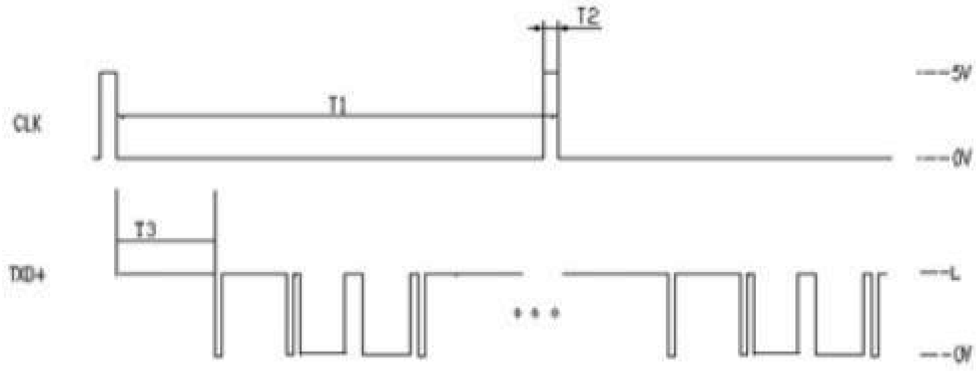
3. 3. 3 Bus commands

(1) Output the data waveform

For example, 0xff 0x81 0xd0...

TXD+ bit transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1...

3. 3V≤L≤5V



The encoder is triggered by the falling edge of an external pulse signal

T2≥10us

T3: The signal acquisition and processing time after receiving the falling edge of the external pulse
T1-T3: Data transmission time
T1 and T3 vary according to the actual requirements or needs of customers.

(2) data frame format

	First byte	The second byte	The third byte	The fourth byte	Fifth byte	The sixth byte	The seventh byte
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight of them are Chinese	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	Next high	Eight of them are Chinese	Low octaves	check sum

(The checksum is the sum of the first n bytes of data with the lower 8 bits. 16 bits or less n=4, 17-24 bits n=5, and more than 24 bits n=6)

(3) mode of connection

pigment	red	black	yellow	hispid arthraxon	ash	white	Citrus sinensis	palm	shield
Signal definition	VCC	0V	TXD+	TXD-	CLK+	CLK-	NC	NC	G

(4) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H are present. The calculation results are: a=383, n=14, θ=(360°×383)/214, θ=(360°×383)/16384, and θ=8.4155°.

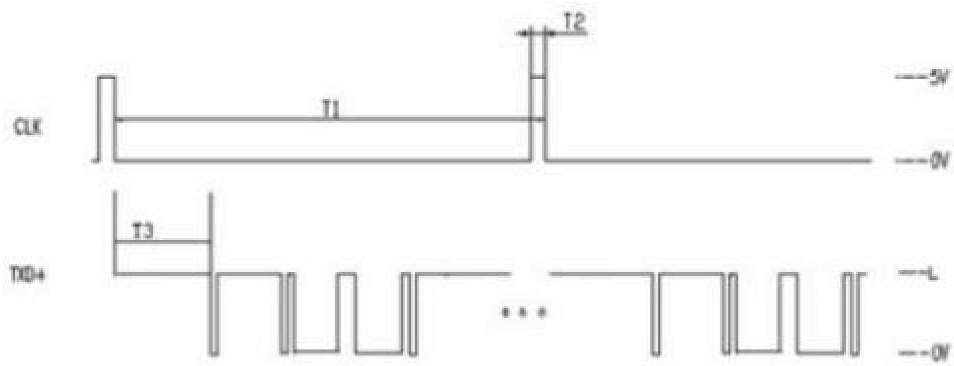
3.3.4 总线+清零

(1) Output the data waveform

For example, 0xff 0x81 0xd0...

TXD+ bit transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1...

3.3V≤L≤5V



The encoder is triggered by the falling edge of an external pulse signal

T2≥10us

T3: The signal acquisition and processing time after receiving the falling edge of the external pulse
T1-T3: Data transmission time
T1 and T3 vary according to the actual requirements or needs of customers.

(2) data frame format

	First byte	The second	The third byte	The fourth	Fifth byte	The sixth byte	The seventh

		byte		byte			byte
Under 16	FFH	81H	Eight high notes	Low octaves	check sum		
17-24	FFH	81H	Eight high notes	Eight of them are Chinese	Low octaves	check sum	
More than 24	FFH	81H	Eight high notes	22 Next high	Eight of them are Chinese	Low octaves	check sum

The CLR pin is usually at 3.3V and the signal falls on the pulse VL<0.5V product reset.

pigment	red	black	yellow	hispid arthraxon	ash	white	Citrus sinensis	palm	shield
Signal definition VCC	0V	TXD+	TXD-	CLK+	CLK-	NC	NC	G	

(4) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns data FFH 81H 01H 7FH 00H, where the data bits 01H 7FH (decimal number 383) and the checksum 00H are present. The calculation results are: a = 383, n = 14, θ = (360° × 383)/214, θ = (360° × 383)/16384, and θ = 8.4155°.

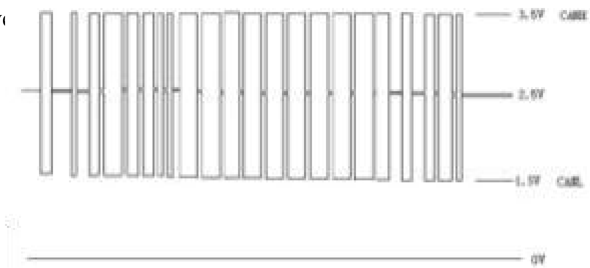
3. 4 CANopen

CANinterface chip--------SN65HVD230 CANopenprotocol

(1) The received data is shown in the following figure:

序列	通道号	时间标识(ms)	传输方向	帧ID (Hex)	帧类型	帧格式	数据长度	数据 (Hex)
002365	0	000936990.5	接收	000001FF	标准帧	数据帧	08	02 2B 00 00 00 00 00 00
002366	0	000937096.9	接收	000001FF	标准帧	数据帧	08	02 2B 00 00 00 00 00 00
002367	0	000937203.3	接收	000001FF	标准帧	数据帧	08	02 2B 00 00 00 00 00 00
002368	0	000937309.7	接收	000001FF	标准帧	数据帧	08	02 2B 00 00 00 00 00 00
002369	0	000937416.1	接收	000001FF	标准帧	数据帧	08	02 2B 00 00 00 00 00 00
002370	0	000937522.5	接收	000001FF	标准帧	数据帧	08	02 2B 00 00 00 00 00 00

Corresponding signal wav



(2) parameter setting

The factory baud rate of the encoder is set to 250K, the node number is set to 20H, and the programming cycle time is 100ms. CANopen data format description:

COB-ID	instruct	index of matrix		subindex		data		
11bit	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
		low-order	high-order		low-order	___	___	high-order

COB-ID composition description:

10	9	8	7	6	5	4	3	2	1	0
Function code				device address						
X	X	X	X	X	X	X	X	X	X	X

Available function codes:

function	code (bit)	COB-ID
NMT	0000	0
SYNC	0001	128(70H)
Emergency	0001	129-255(71H-FFH)
PDO(RX)	0011	385-511(181H-1FFH)
PDO(TX)	0100	513-639(201H-27F)
SDO(RX)	1011	1409-1535(581H-5FFH)
SDO(TX)	1100	1537-1663(601H-67FH)

RX/TX refers to the upper-level machine perspective: RX denotes encoder data transmission while TX indicates data reception. When CAN Open protocol devices are properly connected and configured with correct baud rates, the software automatically receives initial data upon device activation. The current frame ID (e.g., Frame ID 000001FF shown in the diagram) can be observed. At this stage, the encoder node ID is FF, transmitting 2FF, 01, FF, 0,0,0,0,0,0 to initiate the FF encoder.

Note: When entering configuration mode, the frame ID input is 7E5.

(3) Settings of CANopen protocol for absolute encoder:

The CAN bus data format involved below is all frame ID, D0, D1, D2, D3, D4, D5, D6, D7. All the data are 16-bit numbers. Suppose the node number of the encoder is NN and DLC is 8.

①

	frame ID	D0	D1	D2	D3	D4	D5	D6	D7	
transmit by radio：	2NN	01	NN	0	0	0	0	0	0	Start the NN node
Alternatively send:	2NN	80	NN	0	0	0	0	0	0	Click the NN encoder
reply：	1NN	Low octaves	Eight high notes	0	0	0	0	0	0	Send back data

②

	frame ID	D0	D1	D2	D3	D4	D5	D6	D7	
transmit by radio：	7E5	04	01	0	0	0	0	0	0	Enter configuration mode
redispatch：	7E5	11	20	0	0	0	0	0	0	Set the new node address to 0x20
reply：	7E5	11	00	0	0	0	0	0	0	success

③

	frame ID	D0	D1	D2	D3	D4	D5	D6	D7	(00 is 1M,02 is 500K,03 is 250K)
transmit by radio：	7E5	04	01	0	0	0	0	0	0	Enter configuration mode
redispatch：	7E5	13	00	02	0	0	0	0	0	Set the new baud rate to 500K
reply：	7E5	13	00	0	0	0	0	0	0	success

④

	frame ID	D0	D1	D2	D3	D4	D5	D6	D7	
transmit by radio：	2NN	22	NN	0	0	0	0	0	0	Node NN is carrying over
reply：	1NN	22	00	0	0	0	0	0	0	

⑤

	frame ID	D0	D1	D2	D3	D4	D5	D6	D7	
transmit by radio：	2NN	22	NN	0	0	0	0	0	0	NN node reverse carry
reply：	1NN	22	00	0	0	0	0	0	0	

⑥

	frame ID	D0	D1	D2	D3	D4	D5	D6	D7	
transmit by radio：	2NN	20	NN	0	0	0	0	0	0	NN node is centered
reply：	1NN	20	00	0	0	0	0	0	0	

⑦

	frame ID	D0	D1	D2	D3	D4	D5	D6	D7	
transmit by radio：	2NN	31	NN	TT	0	0	0	0	0	NN node data is sent at regular intervals TT times per second. The new node address is 0x20
reply：	1NN	31	00	0	0	0	0	0	0	

⑧

	frame ID	D0	D1	D2	D3	D4	D5	D6	D7	
transmit by radio：	2NN	31	NN	TT	0	0	0	0	0	Stop the scheduled sending mode of NN node
reply：	1NN	31	00	0	0	0	0	0	0	

(4) mode of connection

pigment	red	black	yellow	hispid	white	shield

				arthraxon		
Signal definition	VCC	0V	NC	CANL	CANH	G

(5) Angle conversion formula

θ=(360° × a) / 2^n. (a: data (decimal), n: encoder bit number)

For example, a 14-bit absolute encoder returns the frame ID 0120H and data frame 47H 26H 00H 00H 00H 00H 00H 00H, where the data bits 47H 26H represent the decimal number 9799. The calculation results are: a = 9799, n = 14, θ = (360° × 9799) / 214, θ = (360° × 9799) / 16384, and θ =215.3100°

产品通信

Synchronous serial: At the agreed communication rate, the clock signal frequency and phase of the sender and receiver are always consistent (synchronized).

3.5 SSI

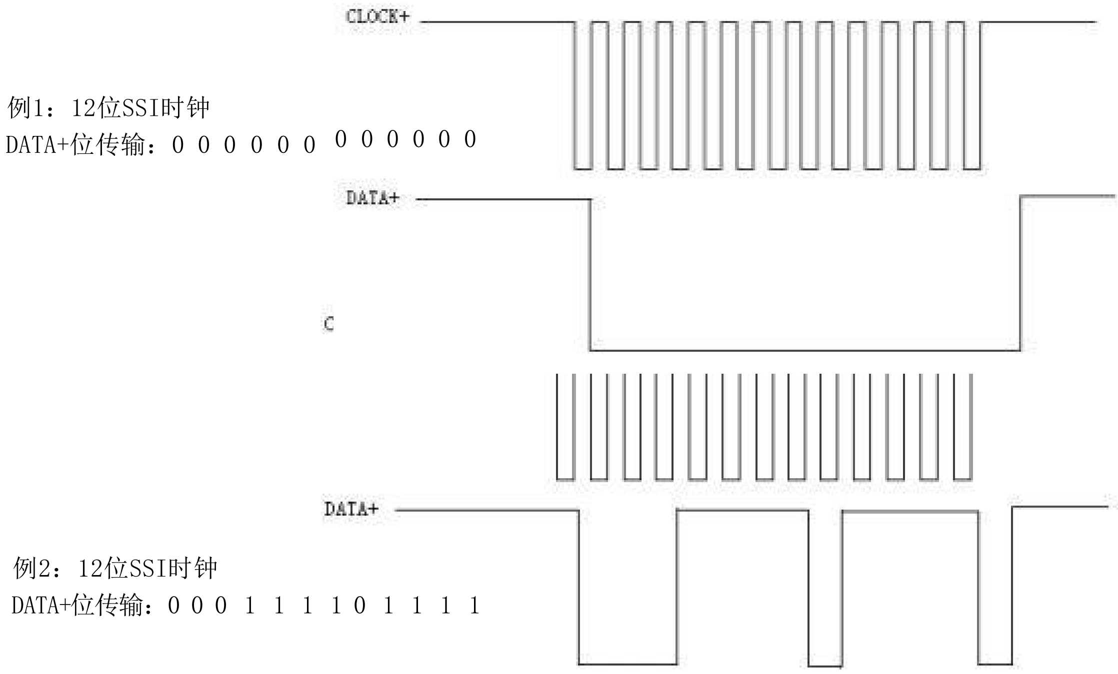
SSI interface chip-MAX3087

Four-wire: differential clock input, differential data output.

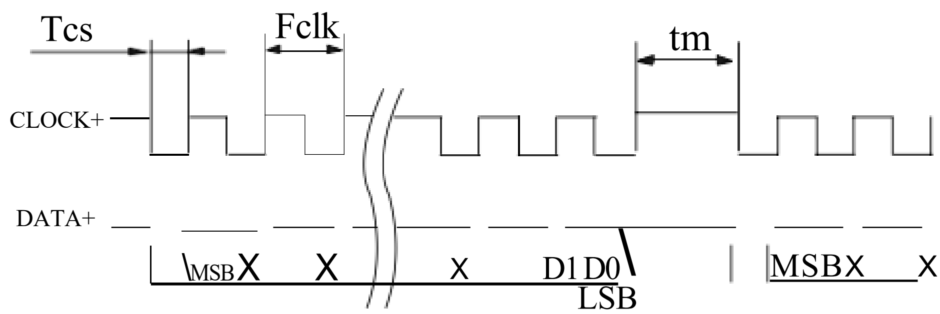
Two-line mode: single-end clock input, single-end data output.

The absolute position value is triggered by the clock signal, which outputs a serial signal synchronized with the clock from the most significant bit (MSB). When no signal is transmitted, both the clock and data remain at high levels. The current value begins storage at the first falling edge of the clock signal, while data transmission starts at the rising edge of the clock. The signal operates within a high-level range of 3.3V to 5V.

Excessive clock signals may cause angular anomalies. For example, when a 12-bit SSI encoder transmits 14-bit clock pulses to read data, the maximum angular value can exceed 1,000 degrees without reaching full 1 status. If the timing is precisely matched, the extra clock pulses may read duplicate high-bit data. Conversely, when clock signals are insufficient, transmitting 8-bit clock pulses to read 12-bit encoder data using an 8-bit angular conversion method might yield error-free results, while employing a 12-bit angular conversion method could result in angular values up to 22.4121 degrees.



（2）



Absolute position value is sometimes triggered by a clock signal to output a serial signal synchronized with the clock signal from the high bit (MSB). When no signal is transmitted, both the clock and data are high. At the first falling edge of the clock signal, the current value starts to be stored, and the data starts to be transmitted at the rising edge of the clock signal.

Note: Tcs> 4us; 100kHz <fclk <250kHz; Tm> 500us;

Note: Tcs fclk Tm varies according to the actual situation and products.

(3) Wiring

mode:
eight-core
cable

pigment	red	black	yellow	hispid arthraxon	ash	white	Citrus sinensis	palm	shield

Signal definition	VCC	0V	NC	D+	C+	C-	NC	D-	G

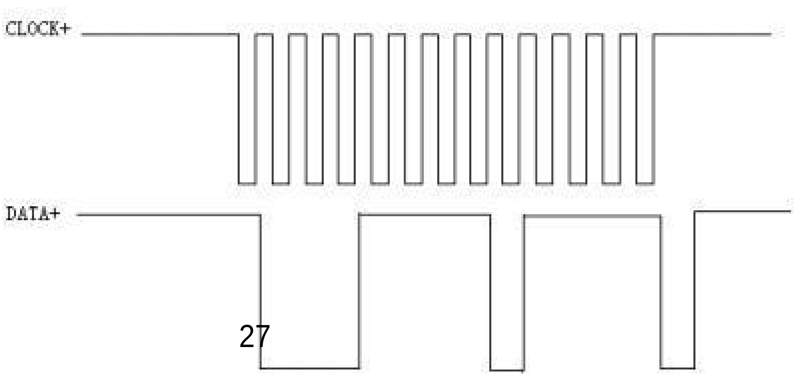
Six-core cable

pigment	red	black	hispid arthraxon	palm	ash	white	shield
Signal definition	VCC	0V	D+	D-	C+	C-	G

(4) Angle conversion formula

$\theta=(360° \times a) / 2^n$. (a: data (decimal), n: encoder bit number)

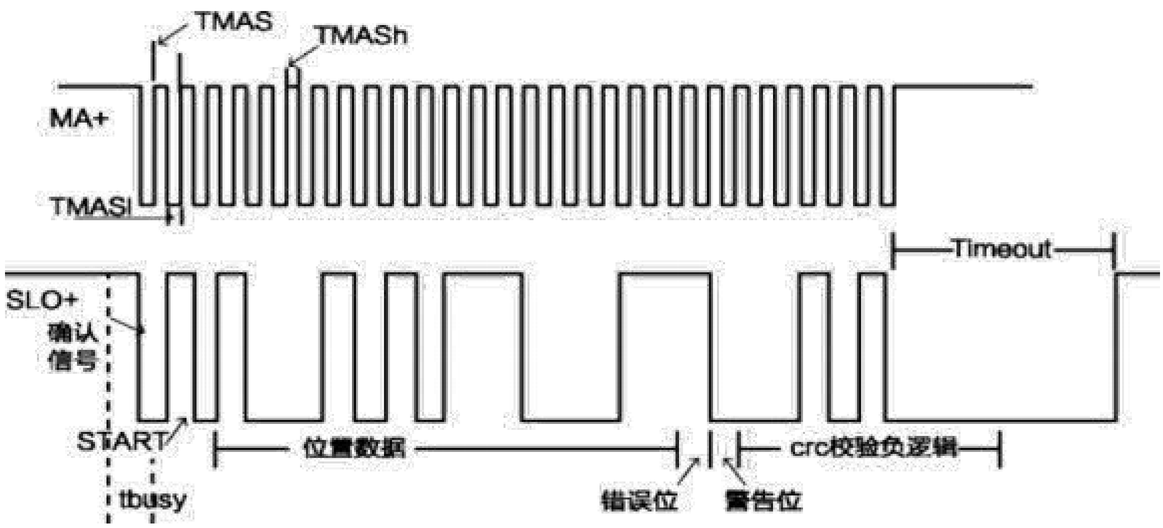
For example, the 12-bit SSI absolute encoder returns data DATA+ bits transmission: 0 0 0 1 1 1 1 0 1 1 1 1 (decimal number 495). a=495, n=12, θ= (360° ×495)/214, θ= (360° ×495)/4096, θ=43.5058 °



3.6 BISSS

The BISSS protocol uses four differential line output mode, only allows binary encoded data, point-to-point configuration, and hardware compatibility with SSI interface.
The first rising edge of MA+ is used to latch the sensor state. The second rising edge of MA+ triggers the encoder to pull SLO+ low, responding to the Master's communication request. Until the start bit (St2) of SLO+ turns "1", indicating data readiness, all bits after this start bit remain "0". Subsequently, the absolute position value is triggered by the rising edge of the clock signal, outputting a serial signal synchronized with the clock from the most significant bit (MSB). Following the position signal are error bits, warning bits, and a 6-bit negative logic CRC check code. The data to be checked includes position data, error bits, warning bits, and the CRC polynomial (g(x)=xA^6 + xM + xA0). The initial value for CRC calculation is set to high levels when no signals are transmitted. Taking the 16-bit sensor data BISS-C protocol transmission as an example: 1000101011100011. Assuming no errors but a warning bit (1) and a warning bit (0), the complete data information code is 100010101110001110. According to the CRC polynomial, the calculated CRC check code is 110101, with its negative logic being 001010

Interface timing diagram

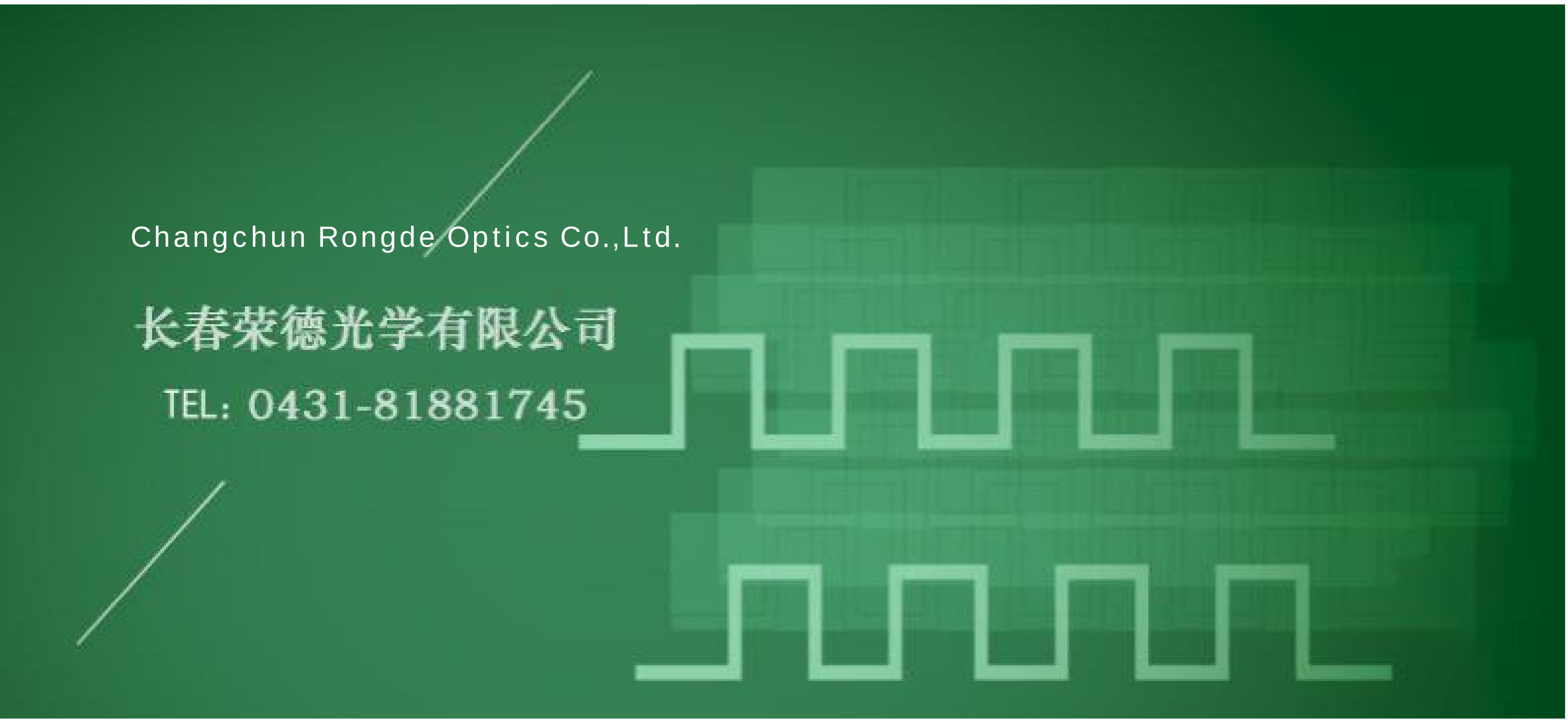


The maximum transmission timing is as follows:
TMAS: The allowed clock cycle is>100ns;
TMASH: High level duration> 25ns;
TMASL: Low level duration>25ns;
Tbusy: Minimum data output delay X2TMAS;
Timeout: Biss timeout 16us.
The drive setting is as follows: The digital drive conversion rate is the fastest 10ns, the digital drive conventional output mode is push-pull output, and the drive output short circuit current is up to 50mA.
Angle conversion formula:

0= (360° × a) / 2 °. (a: data (decimal), n: encoder bit number)

For example, the 6-bit absolute encoder returns data SLO+ transmission: 1000101011100011 (decimal number 35555). a=35555, n=16, θ

= (360° x 35555) /2, θ = (360° x 35555) /65536, θ=195.3094°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